Codes and Standards
Title 24 Energy-Efficient Local Ordinances

Title:
Climate Zone 4
Energy Cost-Effectiveness Study

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1.0 Executive Summary

This report presents the results of Gabel Associates' research and review of the feasibility and energy cost-effectiveness of building permit applicants exceeding the 2008 Building Energy Efficiency Standards to meet the minimum energy-efficiency requirements of local energy efficiency standards covering Climate Zone 4. A local government may use this report as a basis for demonstrating energy cost-effectiveness of a proposed green building or energy ordinance. The study assumes that such an ordinance requires, for the building categories covered, that building energy performance exceeds the 2008 TDV energy standard budget by at least 15%.

The study is also contained in the local government's application to the California Energy Commission (CEC) which must meet all requirements specified in Section 10-106 of the California Code of Regulations, Title 24, Part 1, Article 1: Locally Adopted Energy Standards. An ordinance shall be legally enforceable (a) after the CEC has reviewed and approved the local energy standards as meeting all requirements of Section 10-106; and (b) the ordinance has been adopted by the local government and filed with the Building Standards Commission.

The 2008 Building Energy Efficiency Standards, which took effect on January 1, 2010, are the baseline used to calculate the cost-effectiveness data.

2.0 Methodology and Assumptions

The energy performance impacts of exceeding the performance requirements of the 2008 Title 24 Building Energy Efficiency Standards (2008 Standards) have been evaluated in Climate Zone 4 using the following residential and nonresidential prototypical building types:

Small/Medium Single Family Houses 2-story 1,705 sf and 2,682 sf	**Large Single Family House** 2-story 5,074 sf
Low-rise Multi-family Apartments 8 dwelling units/2-story 8,442 sf	**High-rise Multi-family Apartments** 40 dwelling units/4-story 36,800 sf
Low-rise Office Building 1-story 10,580 sf	**High-rise Office Building** 5-story 52,900 sf

Methodology

The methodology used in the case studies is based on a design process for each of the proposed prototypical building types that first meets the minimum requirements and then exceeds the 2008 Standards by 15%. The process includes the following major stages:

Stage 1: Minimum Compliance with 2008 Standards:

Each prototype building design is tested for minimum compliance with the 2008 Standards, and the mix of energy measures are adjusted using common construction options so the building first just meets the Standards. The set of energy measures chosen represent a reasonable combination which reflects how designers, builders and developers are likely to achieve a specified level of performance using a relatively low first incremental (additional) cost.

Stage 2: Incremental Cost for Exceeding 2008 Standards by 15%:

Starting with that set of measures which is minimally compliant with the 2008 Standards, various energy measures are upgraded so that the building just exceeds the 2008 Standards by 15%. The design choices by the consultant authoring this study are based on many years of experience with architects, builders, mechanical engineers; and general knowledge of the relative acceptance and preferences of many measures, as well as their incremental costs. This approach tends to reflect how building energy performance is typically evaluated for code compliance and how it's used to select design energy efficiency measures. Note that lowest simple payback with respect to building site energy is not the primary focus of selecting measures; but rather the requisite reduction of Title 24 Time Dependent Valuation(TDV) energy at a reasonable incremental cost consistent with other non-monetary but important design considerations. A minimum and

maximum range of incremental costs of added energy efficiency measures is established by a variety of research means. A construction cost estimator, Building Advisory LLC, was contracted to conduct research to obtain current measure cost information for many energy measures; and Gabel Associates performed its own additional research to establish first cost data.

Stage 3: Cost Effectiveness Determination:

Energy savings in kWh and therms is calculated from the Title 24 simulation results to establish the annual energy cost savings and CO_2-equivalent reductions in greenhouse gases. A simple payback analysis in years is calculated by dividing the incremental cost for exceeding the 2008 Standards by the estimated annual energy cost savings.

Assumptions

Annual Energy Cost Savings

1. Annual site electricity (kWh) and natural gas (therms) saved are calculated using Micropas 2008 research energy compliance software for the 2008 Building Energy Efficiency Standards.

2. Average residential utility rates of $0.18/kWh for electricity and $1.15/therm for natural gas in current constant dollars; nonresidential rates are time-of-use rate schedules modeled explicitly in the DOE-2.1E computer simulation: PG&E A-6 schedule for electricity and PG&E G-NR1 schedule for natural gas.

3. No change (i.e., no inflation or deflation) of utility rates in constant dollars

4. No increase in summer temperatures from global climate change

Simple Payback Analysis

1. No external cost of global climate change -- and corresponding value of additional investment in energy efficiency and CO_2 reduction – is included

2. The cost of money (e.g., opportunity cost) invested in the incremental cost of energy efficiency measures is not included.

3.0 Minimum Compliance with 2008 Standards

Energy design descriptions of the single family building prototypes which just meet the 2008 Title 24 Building Energy Efficiency Standards:

Single Family House: 1,705 square feet, 2-story, 16.3% glazing/floor area ratio – Option A

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: 13 SEER
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heater: EF=0.60

Single Family House: 1,705 square feet, 2-story, 16.3% glazing/floor area ratio – Option B

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioning: None
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heater: EF=0.60

Single Family House: 2,682 square feet, 2-story, 21.1% glazing/floor area ratio – Option A

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-15 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: 13 SEER
R-8 Attic Ducts
50 Gallon Gas Water Heaters: EF=0.60

Single Family House: 2,682 square feet, 2-story, 21.1% glazing/floor area ratio – Option B

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-15 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: None
R-8 Attic Ducts
50 Gallon Gas Water Heaters: EF=0.60

Single Family House: 5,074 square feet, 2-story, 22.7% glazing/floor area ratio – Option A

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Housewrap
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(2) Furnaces: 80% AFUE
(2) Air Conditioners: 13 SEER
(2) Air Conditioners: TXV + Refrig. Charge (HERS)
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.62
Pipe Insulation

Single Family House: 5,074 square feet, 2-story, 22.7% glazing/floor area ratio – Option B

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Housewrap
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(2) Furnaces: 80% AFUE
(2) Air Conditioners: 13 SEER
(2) Air Conditioners: TXV + Refrig. Charge (HERS)
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.62
Pipe Insulation

Low-rise Multi-family Residential: 2-story 8,442 square feet, 8 units, 12.5% glazing

Option 1

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(8) Furnaces: 80% AFUE
(8) Air Conditioners: 13 SEER
R-6 Attic Ducts
(8) 40 Gallon Gas Water Heaters: EF=0.62

Option 2

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(8) Furnaces: 80% AFUE
Air Conditioners: None
R-6 Attic Ducts
(8) 40 Gallon Gas Water Heaters: EF=0.62

High-rise Residential: 4-story 36,800 sf, 40 units,
Window Wall Ratio = 35.2%

Energy Efficiency Measures
R-30 Roof
R-19 Metal Stud Walls
R-0 Raised Slab
Low E2 Vinyl Windows, U=0.36, SHGC=0.35
Room PTACs: HSPF=7.2, EER=10.2 (No Ducts)
Central DHW Boiler, AFUE=82.7%

Nonresidential: 1-story office building, 10,580 sf
Window Wall Ratio = 24.1%

- R-30 attic insulation, R-19 in metal frame exterior walls, slab-on-grade 1st floor;
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) w/ no exterior shading
- Lighting = 0.852 w/sf: 120 2-lamp 4' T8 fixtures @ 62w each and 100 26w CFLs @ 26 w each; 6 50w-halogens; no lighting controls
- (4) 7.5-ton Packaged DX units: 11.0 EER; 80% AFUE; all standard efficiency fan motors
- Ducts in conditioned space, R-4.2 duct insulation
- Domestic hot water assumed to be standard gas water heater

Nonresidential: 5-story office building, 52,900 sf
Window Wall Ratio = 29.1%

- R-30 attic insulation, R-19 in metal frame exterior walls, slab-on-grade 1st floor;
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) w/ 2' overhang on 1st floor only
- Lighting = 0.909 w/sf: 720 2-lamp 4' T8 fixtures w/ high efficiency ballasts @ 58w each and 230 26w CFLs @ 26 w each; no lighting controls
- 4 identical Packaged VAV units: Aaron 25 ton, EER=10.4, 10,000 CFM, standard efficiency fan motors, 30% VAV boxes w/ reheat
- Ducts in conditioned space, R-4.2 duct insulation
- Hot water assumed to be standard gas water heater or boiler

4.0 Incremental Cost to Exceed 2008 Standards by 15%

The following tables list the energy features and/or equipment included in the 2008 Standards base design, the efficient measure options, and an estimate of the incremental cost for each measure included **to improve the building performance to use 15% less TDV energy than the corresponding Title 24 base case design**.

Small Single Family House

- 1,705 square feet
- 2-story

15% Better Than Title 24 Base Case, Option A **1705 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 1,328 sf @ $0.31 to $0.54/sf	Upgrade	$ 412	$ 717	$ 564
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,000	$ 750
Air Conditioner: 13 SEER, 11 EER (HERS)	Upgrade	$ 25	$ 75	$ 50
Air Conditioner: TXV + Refrig. Charge (HERS)	Upgrade	$ 100	$ 150	$ 125
R-8 Attic Ducts (from R-6)	Upgrade	$ 225	$ 325	$ 275
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	$ 100	$ 200	$ 150
Total Incremental Cost of Energy Efficiency Measures:		**$ 1,362**	**$ 2,467**	**$ 1,914**
Total Incremental Cost per Square Foot:		**$ 0.80**	**$ 1.45**	**$ 1.12**

15% Better Than Title 24 Base Case, Option B **1705 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 1,328 sf @ $0.31 to $0.54/sf	Upgrade	$ 412	$ 717	$ 564
R-0 Slab on Grade	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 92% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,200	$ 850
Air Conditioning: None	-	$ -	$ -	$ -
R-8 Attic Ducts (from R-6)	Upgrade	$ 225	$ 325	$ 275
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	$ 100	$ 200	$ 150
Total Incremental Cost of Energy Efficiency Measures:		**$ 1,237**	**$ 2,442**	**$ 1,839**
Total Incremental Cost per Square Foot:		**$ 0.73**	**$ 1.43**	**$ 1.08**

Medium Single Family House

- 2,682 square feet
- 2-story

15% Better Than Title 24 Base Case, Option A **2682 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-15 Walls	-	$ -	$ -	$ -
R-19 Floor	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,000	$ 750
Air Conditioner: 13 SEER, 11 EER (HERS)	Upgrade	$ 25	$ 75	$ 50
Air Conditioner: TXV + Refrig. Charge (HERS)	Upgrade	$ 100	$ 150	$ 125
R-8 Attic Ducts	-	$ -	$ -	$ -
Reduced Duct Leakage/Testing (HERS)	Upgrade	$ 300	$ 600	$ 450
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	$ 100	$ 200	$ 150
Total Incremental Cost of Energy Efficiency Measures:		**$ 1,025**	**$ 2,025**	**$ 1,525**
Total Incremental Cost per Square Foot:		**$ 0.38**	**$ 0.76**	**$ 0.57**

15% Better Than Title 24 Base Case, Option B **2682 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-15 Walls	-	$ -	$ -	$ -
R-19 Floor	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
Housewrap: 2,137 sf @ $0.50 to 0.75/sf	Upgrade	$ 1,069	$ 1,603	$ 1,336
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	$ 500	$ 1,000	$ 750
Air Conditioner: None	-	$ -	$ -	$ -
R-8 Attic Ducts	-	$ -	$ -	$ -
Reduced Duct Leakage/Testing (HERS)	Upgrade	$ 300	$ 600	$ 450
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	$ 100	$ 200	$ 150
Total Incremental Cost of Energy Efficiency Measures:		**$ 1,969**	**$ 3,403**	**$ 2,686**
Total Incremental Cost per Square Foot:		**$ 0.73**	**$ 1.27**	**$ 1.00**

Large Single Family House

- 5,074 square feet
- 2-story

15% Better Than Title 24 Base Case, Option A **5074 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 2,590 sf @ $0.31 to $0.54/sf	Upgrade	$ 803	$ 1,399	$ 1,101
R-30 Raised Floor (from R-19): 3,044 sf @ $0.25 to $0.35	Upgrade	$ 761	$ 1,065	$ 913
Housewrap	-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(2) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	$ 1,000	$ 2,400	$ 1,700
(2) Air Conditioners: 13 SEER, 11 EER (HERS)	Upgrade	$ 50	$ 150	$ 100
(2) Air Conditioners: TXV + Refrig. Charge (HERS)	-	$ -	$ -	$ -
R-8 Attic Ducts (from R-6)	Upgrade	$ 400	$ 600	$ 500
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62	-	$ -	$ -	$ -
Pipe Insulation	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 3,014**	**$ 5,614**	**$ 4,314**
Total Incremental Cost per Square Foot:		**$ 0.59**	**$ 1.11**	**$ 0.85**

15% Better Than Title 24 Base Case, Option B **5074 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-15): 2,590 sf @ $0.15 to $0.40/sf	Upgrade	$ 389	$ 1,036	$ 712
R-19 Floor	-	$ -	$ -	$ -
Housewrap	-	$ -	$ -	$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23, 1151.8 sf @ $1.40 - $1.75 / sf	Upgrade	$ 1,613	$ 2,016	$ 1,814
(2) Furnaces: 90% AFUE (from 80% AFUE)	Upgrade	$ 1,000	$ 2,000	$ 1,500
Air Conditioners: None	-	$ -	$ -	$ -
R-6 Attic Ducts	-	$ -	$ -	$ -
Reduced Duct Leakage/Testing (HERS)	-	$ -	$ -	$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 3,001**	**$ 5,052**	**$ 4,026**
Total Incremental Cost per Square Foot:		**$ 0.59**	**$ 1.00**	**$ 0.79**

Low-rise Multi-family Apartments

- 8,442 square feet
- 8 units/2-story
- 12.5% glazing/floor area ratio

15% Better Than Title 24 Base Case, Option A **8442 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	$ -	$ -	$ -
R-19 Walls (from R-13): 10,146 sf @ $0.31 to $0.54/sf	Upgrade	$ 3,145	$ 5,479	$ 4,312
R-0 Slab on Grade	-	$ -	$ -	$ -
Housewrap: 10,146 sf @ $0.50 to 0.75/sf	Upgrade	$ 5,073	$ 7,610	$ 6,341
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(8) Furnaces: 80% AFUE	-	$ -	$ -	$ -
(8) Air Conditioners: 13 SEER	-	$ -	$ -	$ -
R-6 Attic Ducts	-	$ -	$ -	$ -
(8) 40 Gallon Gas Water Heaters: EF=0.63 (from 0.62 EF)	Upgrade	$ -	$ 600	$ 300
Total Incremental Cost of Energy Efficiency Measures:		**$ 8,218**	**$ 13,688**	**$ 10,953**
Total Incremental Cost per Square Foot:		**$ 0.97**	**$ 1.62**	**$ 1.30**

15% Better Than Title 24 Base Case, Option B **8442 sf** **Climate Zone 4**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier (from R-38 w/Radiant Barrier): 4,221 sf @ $0.20 to $0.15/sf	Downgrade	$ (844)	$ (633)	$ (739)
R-21 Walls (from R-13): 10,146 sf @ $0.45 to $0.70/sf	Upgrade	$ 4,566	$ 7,102	$ 5,834
R-0 Slab on Grade	-	$ -	$ -	$ -
Housewrap: 10,146 sf @ $0.50 to 0.75/sf	Upgrade	$ 5,073	$ 7,610	$ 6,341
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	$ -	$ -	$ -
(8) Furnaces: 80% AFUE	-	$ -	$ -	$ -
(8) Air Conditioners: 13 SEER	-	$ -	$ -	$ -
R-6 Attic Ducts	-	$ -	$ -	$ -
(8) 40 Gallon Gas Water Heaters: EF=0.62	-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:		**$ 8,795**	**$ 14,079**	**$ 11,437**
Total Incremental Cost per Square Foot:		**$ 1.04**	**$ 1.67**	**$ 1.35**

High-rise Multifamily Apartments

- 36,800 sf,
- 40 units/4-story
- Window to Wall Ratio = 31.6%

15% Better Than Title 24 Base Case, Option A **36800 sf**

Energy Efficiency Measures		Change Type	Incremental Cost Estimate Min	Max	Avg
R-30 Cool Roof (Reflectance=0.70, Emmittance=0.75); 9,200 sf @ $0.25 - $0.40/sf		Upgrade	$ 2,300	$ 3,680	$ 2,990
R-19 Metal Stud Walls		-	$ -	$ -	$ -
R-0 Raised Slab		-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.25 6,240 sf @ $1.40 - $1.60/sf		Upgrade	$ 8,736	$ 9,984	$ 9,360
Room PTACs: HSPF=7.84, EER=11.2 (No Ducts) units @ $150 - $250/unit	80	Upgrade	$ 12,000	$ 20,000	$ 16,000
Central DHW Boiler, AFUE=82.7%		-	$ -	$ -	$ -
Total Incremental Cost of Energy Efficiency Measures:			**$ 23,036**	**$ 33,664**	**$ 28,350**
Total Incremental Cost per Square Foot:			**$ 0.63**	**$ 0.91**	**$ 0.77**

15% Better Than Title 24 Base Case, Option B **36800 sf**

Energy Efficiency Measures		Change Type	Incremental Cost Estimate Min	Max	Avg
R-30 Roof		-	$ -	$ -	$ -
R-19 Metal Stud Walls		-	$ -	$ -	$ -
R-0 Raised Slab		-	$ -	$ -	$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.25 6,240 sf @ $1.40 - $1.60/sf		Upgrade	$ 8,736	$ 9,984	$ 9,360
Room PTACs: HSPF=7.84, EER=11.2 (No Ducts) units @ $150 - $250/unit	80	Upgrade	$ 12,000	$ 20,000	$ 16,000
Central DHW Boiler, AFUE=94%: 2 @ $2000 - $3000 each		Upgrade	$ 3,000	$ 6,000	$ 4,500
Total Incremental Cost of Energy Efficiency Measures:			**$ 23,736**	**$ 35,984**	**$ 29,860**
Total Incremental Cost per Square Foot:			**$ 0.65**	**$ 0.98**	**$ 0.81**

Low-rise Office Building

- Single Story
- 10,580 sf,
- Window to Wall Ratio = 37.1%

15% Better than Title 24 Base Case, Option 1

• Lighting = 0.693 w/sf: 120 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$35.00 - $60.00/fixture	$ 4,200 - 7,200
• 30 (25% of) T8 fixtures on 15 occupant sensors, small offices: @$75.00 - $100.00 each	$ 1,125 - 1,500
• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 1,960 sf @$2.00 - 3.00/sq.ft.	$ 3,920 - 5,880
• R-30 cool roof Reflectance=0.70, Emmittance=0.75 10,580 sf @ $0.35 - $0.50/sf	$ 3,705 - 5,290
Total incremental cost of Ordinance:	**$ 12,950 - 19,870 Avg = $16,410**
Incremental cost in $/SF:	**$ 1.22 to $1.88/sq.ft. Avg = $1.55 /sf**

15% Better than Title 24 Base Case, Option 2

• Lighting = 0.693 w/sf: 120 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$35.00 - $60.00/fixture	$ 4,200 - 7,200
• (4) Global Energy Group 1400 Series 7.5-ton Packaged DX, EER = 13.0 @$1950 - $2450 each	$ 7,800 - 9,800
• R-30 cool roof Reflectance=0.70, Emmittance=0.75 10,580 sf @ $0.35 - $0.50/sf	$ 3,705 - 5,290
Total incremental cost of Ordinance:	**$ 15,705 - 22,290 Avg = $18,998**
Incremental cost in $/SF:	**$ 1.48 to $2.11/sq.ft. Avg = $1.80 /sf**

High-rise Office Building

- 5-story
- 52,900 sf,
- Window to Wall Ratio = 34.5%

15% Better than Title 24 Base Case

• (5) Trane 25 ton units, EER=11.0 @ $9,000 to $13,000 each w/ premium fan motors	$ 45,000 - 65,000
• 10 NEMA Premium fan motors on supply & return fans	$ 750 - 1,250
• R-38 w/ Cool Roof 10,580 sf @ $0.40 - $0.50/sf	$ 4,235 - 5,290
• Installed LPD=0.785: 720 2-lamp 4' T8 fixtures w/ high eff. instant start ballasts and premium T8 lamps, 50w input @$10.00 - $20.00/fixture	$ 7,200 - 14,400
• Switch 20 (< 9%) of 26w CFLs to 18w CFLs	$ 0 - 0
• 100 occupant sensors controlling (2) 2-lamp T8 fixtures; @$75.00 - $100.00 each	$ 7,500 - 10,000
• R-21 in exterior walls: 20,730 sf @ $0.08 - $0.12/sf	$ 1,660 - 2,490
• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 8,500 sf @$2.00 - 3.00/sq.ft.	$ 17,000 - 25,500
Total incremental cost of Ordinance:	**$ 83,345 - 123,930 Avg = $103,638**
Incremental cost in $/SF:	**$ 1.58 to $2.34/sq.ft. Avg = $1.96 /sf**

5.0 Cost -Effectiveness Determination

Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings in exceeding the 2008 Standards is determined to be cost-effe ctive. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental costs for exceeding 2008 Standards, estimated annual energy cost savings, and subsequent payback period.

Small Single Family

Building Description	Average Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
1,705 sf (OptA-15%)	$1,915	$107	17.9
1,705 sf (OptB-15%)	$1,840	$110	16.7
Averages:	$1,877	$109	17.3

Annual Reduction in CO2-equivalent: 0.41 lb./sq.ft.-year

Medium Single Family

Building Description	Average Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
2,682 sf (OptA-15%)	$1,525	$165	9.2
2,682 sf (OptB-15%)	$2,686	$177	15.2
Averages:	$2,106	$171	12.2

Annual Reduction in CO2-equivalent: 0.41 lb./sq.ft.-year

Large Single Family

Building Description	Average Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
5,074 sf (OptA-15%)	$4,314	$223	19.3
5,074 sf (OptB-15%)	$4,027	$218	18.5
Averages:	$4,170	$221	18.9

Annual Reduction in CO2-equivalent: 0.28 lb./sq.ft.-year

Low-rise Multi-family Apartments

Building Description	Total Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
8,442 sf (OptA-15%)	$10,953	$461	23.8
8,442 sf (OptB-15%)	$11,437	$454	25.2
Averages:	$11,195	$458	24.5

Annual Reduction in CO2-equivalent: 0.43 lb./sq.ft.-year

High-rise Multi-family Apartments

Building Description	Average Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
36,800 sf (Opt-A -15%)	$28,350	$2,106	13.5
36,800 sf (Opt-B -15%)	$29,860	$2,855	10.5
Averages:	$29,105	$2,481	12.0

Annual Reduction in CO2-equivalent: 0.32 lb./sq.ft.-year

Low-rise Office Building

Building Description	Total Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
10,580 sf (A1)	$7,013	$1,534	4.6
10,580 sf (A2)	$13,298	$1,638	8.1
Averages:	$10,155	$1,586	6.3

Annual Reduction in CO2-equivalent: 0.48 lb./sq.ft.-year

High-rise Office Building

Building Description	Total Incremental First Cost ($)	Net Incremental Annual Energy Cost Savings ($)	Simple Payback (years)
52,900 sf (A1)	$71,563	$6,781	10.6

Annual Reduction in CO2-equivalent: 0.38 lb./sq.ft.-year

Conclusions

Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings which exceed the 2008 Title 24 Building Energy Efficiency Standards by 15% appears cost-effective. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental first cost and payback. As with simply meeting the requirements of the Title 24 energy standards, a permit applicant complying with the energy requirements of a green building ordinance should carefully analyze building energy performance to reduce incremental first cost and increase the payback for the required additional energy efficiency measures.